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13. ABSTRACT *(Maximum 200 words)*

A study of nonlinear differential and integral equations which describe time-dependent phenomena in fluids and solids has been conducted by a team of investigators at the University of Georgia. The methods of study employed include computer simulations, recurrence relations, linearization. Among significant findings are a demonstration of slow decay in a Hermitian many-body system for the first time. The origin & mechanisms of slow decay have been elucidated. The study has resulted in nearly 30 articles, most of which are in refereed journals of international standing.

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7. STATEMENT OF THE PROBLEM

A study of nonlinear partial differential and integral–differential equations which describe time–dependent phenomena in fluids and solids was undertaken by an interdisciplinary team of investigators at the University of Georgia. Emphasis was placed on approximations of water wave equations and related nonlinear optics, dvnamical lattice equations, and nonlinear Langevin equation. The methods of study employed were principally computer simulations, recurrence relations, linearization, representation theory of infinite dimensional Lie algebras and group, and inverse scattering transformations.

8. SUMMARY OF THE MOST IMPORTANT RESULTS

The efforts of our project team have resulted in nearly 30 publications, most of which have appeared in refereed journals of international standing. Because of the diversity in our output, it is difficult to judge as to which articles are more important than the others. Some articles represent certain stages of development, which later when completed may prove to be even more significant than as appeared earlier. Bearing this point in mind, we shall select a work of substantial nature which has been completed during the project period as our most important. By this criterion, the most important results of our project are represented by our publications 26 and 27.

The research findings given in these two publications concern slow decay in many–particle systems. Is there a memory in thermodynamic systems? Whether slow decay exists in an Hermitian system has been an open problem ever since numerical studies showed evidence some two decades ago. In these two articles, we have finally demonstrated rigorously that slow decay can exist under certain subtle conditions for the first time. Furthermore, the origin and mechanisms of slow decay have been elucidated. The underlying physical process in spin systems (i. e., models of magnetism) responsible for slow decay turns out to be spin precession. It suggests that mechanisms of slow decay in fluids are likely to be vorticity and vortex motion. The results stated here were obtained by solving the Heisenberg equation of motion (i. e., nonlinear Langevin equation) exactly and then by carrying out the required ensemble averages for an asymptotic time domain. Also interesting was the determination of the time domain which may be regarded as asymptotic.

9. LIST OF PARTICIPATING SCIENTIFIC PERSONNEL

A. Co–Principal Investigators

M. H. Lee, R. L. Anderson, R. A. Kunze

B. Other Investigators

D. P. Landau, M. Adams, R. Varley, T. R. Taha, J. Dorfmeister

C. Students Receiving Advanced Degrees

S. Sen, Ph.D in 1989 (under the direction of Professor M. H. Lee)
Title of Dissertation: Transverse Spin Dynamics of Ising Models in one, two and three dimensions.

10. LIST OF PUBLICATIONS

1. T. Taha and M. J. Ablowitz
Analytical and numerical aspects of certain nonlinear evolution equations; IV. Numerical Modified KdV equation
J. Comp. Phys. 77, 540–548 (1988).

2. M. H. Lee
Method of recurrence relations and time evolution problems in statistical mechanics
Math/Chem/Comp 1988, Proc. of Int. Conf. on the Interface between Mathematics, Chemistry and Compute Science, Dubrovnik, Yugoslavia, 20–25 June 1988, Ed. A. Graovac, Elsevier (Amsterdam, the Netherlands).

3. M. H. Lee
Propagation of electron beams in inhomogeneous media
SPIE–Int. Soc. Opt. Eng. 874, 290–295 (1988).

4. M. R. Adams and J. Harnad
A Generating Function Proof of the Commutativity of Certain Hamiltonian Isospectral Flows.
Lett. Math. Phys. 16, 269–272 (1988).

5. M. H. Lee
Note on certain integrals of Bessel functions
J. Phys. A: Math. Gen. 21, 4341–4345 (1988).

6. J. Florencio and M. H. Lee
Memory functions and relaxation functions of some spin systems
Nucl. Phys. B, 5A, 250–254 (1988).

7. M. H. Lee
Frequency moment sum rules, recurrence relations and continued fractions in nonequilibrium statistical mechanics
Computer Phys. Comm. 53, 147–155 (1989).

8. M. H. Lee and J. Hong
Asymptotic behavior of a dynamic local field: Is the order of the $k \to \infty$ and $\omega \to \infty$ limits interchangeable in an interacting many–body system?
J. Phys. Condens. Matter 1, L3867–3872 (1989).

9. J. Hong, J. Park and M. H. Lee
Dynamic local field, sum rules and dynamic structure factor of a classical plasma with a log. potential in two dimensions at $\Gamma = 2$
Phys. Rev. B30, 1528–1537 (1989).

10. M. H. Lee, J. Florencio and J. Hong
Dynamic equivalence of a two–dimensional quantum electron gas and a classical harmonic oscillator chain with an impurity mass.
J. Phys. A Math. Gen. 22, L331–335 (1989).

11. M. H. Lee
Chemical Potential of a D–Dimensional Free Fermion Gas at Finite Temperatures
J. Math Phys. 30, 1837–1839 (1989).

12. M. B. Yu, J. H. Kim and M. H. Lee
Time evolution and delocalization in models of harmonic oscillator chains with an impurity.
J. Luminesc. 45, 144 (1990).

13. M. H. Lee & J. T. Nelson
Frequency–dependent susceptibility of a free electron gas in D dimensions.
J. Math. Phys. 31, 689 (1990).

14. M. H. Lee
Fermionic Chemical Potential.
J. Math. Chem. 5, 83 (1990).

15. D. Y. Kim, R. W. Gerling and D. P. Landau
Spin dynamics study of the classical anisotropic XY chain.
Phys. Rev. B 42, 631 (1990)

16. T. R. Taha
A parallel algorithm for the IST scheme.
Proc. 4th Conf. on Hypercubes, Concurrent Computers, and Applications Monterey, CA (1990), pp. 1223–26.

17. T. R. Taha
A new IST numerical scheme for the nonlinear Schrödinger equation.
Proc. First IMACS Int. Conf. on Comp. Phys., Boulder, 1990 pp. 154–159.

18. R. W. Gerling and D. P. Landau
Time dependent behavior of classical spin chains at infinite temperature.
Phys. Rev. B 42, 8214 (1990).

19. T. R. Taha
Numerical simulation of the nonlinear Schrödinger equation
J. Math. and Comp. in Simulation 32, 309–312 (1990).

20. T. R. Taha
A parallel algorithm in solving higher order KdV equations on a hypercube
Proc. 5th Distributed Memory Computing Conf., ed. D. W. Walker & Q. F. Stout, Vol. 1, 564–567 (1990).

21. T. R. Taha
Solution of periodic tridiagonal linear systems of equations on a hypercube
Proc. 5th Distributed Memory Computing Conf., ed. D. W. Walker & Q. F. Stout, Vol. 1, 346–350 (1990).

22. M. R. Adams et al
Dual Moment Maps in Loop Algebras
Lett. Math. Phys. 20, 299 (1990).

23. M. R. Adams et al
Finite dimensional integrable Hamiltonian systems in loop algebras
Proc. Workshop on Integrable Hamiltonian Systems, ed. J. Harnad & J. E. Marsden, Les Publication CRM, Montreal, 1990.

24. M. R. Adams et al
Liouville Generating Functions for Isospectral Flow in Loop Algebras.
Integral & Superintegrable Systems, ed. B. Kuperschmidt, World Scientific, Singapore, 1990

25. M. R. Adams, R. Anderson & R. Varley
Remarks on Integrable Hierarchies in Finite Dimensions
Hamiltonian Systems, Transformation Groups & Spectral Transform Methods
Ed. J. Harnad & J. E. Marsden, Les Publications CRM, Montreal, 1990.

26. R. Dekeyser & M. H. Lee
Nonequilibrium statistical mechanics of the spin van der Waals Model:
I. Time evolution of a single spin
Phys. Rev. B 43, 8123 (1991).

27. R. Dekeyser & M. H. Lee
Nonequilibrium statistical mechanics of the spin van der Waals Model:
II. Autocorrelation function and long time tails
Phys. Rev. B 43, 8131 (1991).